

Appl. No. 10/801,165
Amdt. dated July 08, 2005
Reply to Office action of May 09, 2005

Amendments to the Specification:

Please replace the paragraph beginning at page 1, line 12, with the following amended paragraph.

Typically, in a simple transition feed for a waveguide the probe does not touch the upper surface and may require additional elements for impedance matching. One such probe design that extends partially into the waveguide is illustrated in U.S. Patent No. 5,867,073, to Sander Weinreb and Dean Bowyer which issued February 2, 1999. Disclosed in U.S. Patent No. 5,867,073 is a transition between a waveguide and a transmission line in which a probe portion of the transmission line extends into the waveguide to electrically field couple signals between the waveguide and transmission line. The transmission line ~~is a coplaner fuse and~~ includes a substrate having conductors disposed therein to prevent energy from propagating into the substrate from the waveguide. Since the probe is formed as an integral element of the transmission line, direct coupling of the waveguide's signals to the transmission line occurs.

Please replace the paragraph beginning at page 3, line 7, with

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the following amended paragraph.

The impedance matching feed consist of a matching transformer located within the ridge of the waveguide. The feed matches a standard coaxial transmission line, which is generally fifty ohms, and does not require an external matching network. A probe extends, from the transformer, vertically upward within the waveguide's interior to the upper wall of the waveguide and is electrically connected to the waveguide. One end of the waveguide is terminated in a quarter wave choke, ~~which is a short approximating $\lambda_g/4$.~~ The quarter wave choke is a short circuit positioned at one quarter of the waveguide's wavelength.

Please replace the paragraph beginning at page 3, line 16 with the following paragraph.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view of an impedance matching feed partially located in a ridge waveguide comprising one embodiment of the present invention;

Figs. 2a and 2b are electrical equivalent circuit diagrams

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for the impedance matching feed of FIG. 1;

Fig. 3 is a cross sectional view of an impedance matching feed comprising a second embodiment of the invention which has a tapered transformer; and

Fig. 4 is a cross sectional view of an impedance matching feed comprising a third embodiment of the invention which has a stepped transformer with each step of the stepped transformer having the same length;

Fig. 5 is an end view of the ridge waveguide of Fig. 1 which illustrates the quarter wave choke positioned at the end of the ridge waveguide; and

Fig. 6 is a cross sectional view of an impedance matching feed comprising a third embodiment of the invention which has a stepped transformer with each step of the stepped transformer having a different length.

Please replace the paragraph beginning at page 4, line 13, with the following amended paragraph.

The waveguide 16 is formed of a hollow interior 18 with open

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ends to receive and deliver radio frequency signals. Waveguide 16, which has a rectangular shape, includes an upper or top wall 20, a lower or bottom wall 22 and a pair of side walls 24 and 26. A ridge 28, which is located at or near the center of the waveguide 16, runs the length of waveguide 16, and extends vertically upward from bottom or lower wall 22 of the waveguide 16. One end of the waveguide 16 is terminated with a quarterwave choke 29 (Fig. 5), ~~which is a short approximately $\lambda_g/4$.~~ The quarter wave choke 29 (Fig. 5) is a short circuit positioned at one quarter of the wavelength for waveguide 16 between upper wall 20 and lower wall 22.

Please replace the paragraph beginning at page 5, line 23, with the following amended paragraph.

Referring now to Figs. 1, 2a and 2b, an electrical equivalent circuit for the feed to the waveguide is depicted in Figs. 2a and 2b. In Figs. 2a and 2b, L_1 (Fig. 2a) is the length for the ~~shorted~~ short circuited end of waveguide 16 and L_2 (Fig. 2b) is the length for transformer 30. Z_{44-44} (Fig. 2b) is the impedance looking into transformer 30 when transformer 30 is terminated with the characteristic impedance for the coaxial

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transmission line 14. Z_g (Fig. 2a) is the waveguide impedance. Z_{coax} (Fig. 2b) is the impedance of coaxial transmission line 14 which is normally fifty ohms but Z_{coax} (Fig. 2b) may have another value. $Z_t(L_2)$ (Fig. 2b) is the impedance of the transformer 30 which can be variable as a function of transformer length, or $Z_t(L_2)$ (Fig. 2b) can be a constant impedance.

Please replace the paragraph beginning at page 6, line 12, with the following amended paragraph.

To obtain an impedance match with coaxial transmission line 14 at reference plane 42-42, the reactances must be tuned out. The diameter of probe 10 may be shaped to tune reactances to a desired level, when needed. Shunt susceptance is made zero by terminating the waveguide with a quarterwave choke. A match occurs when Z_{44-44} (Fig. 2b) is the same as the waveguide impedance Z_g (Fig. 2a). Since Z_{44-44} (Fig. 2b) is the impedance looking into transformer 30, the impedance profile $Z_t(L_2)$ (Fig. 2b) can be selected to make Z_{44-44} (Fig. 2b) match the waveguide impedance Z_g (Fig. 2a).

Please replace the paragraph beginning at page 7, line 2,

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with the following amended paragraph.

For the relatively simple case of a single step quarter wave transformer, the impedance $Z_t(L_2)$ (Fig. 2b) is kept constant and the length L_2 (Fig. 2b) is selected to be $\lambda/4$ at the operating frequency. The impedance Z_s looking toward the short is:

$$Z_s = jZ_g \tan \beta L_1 \quad (1)$$

where Z_g is the impedance of waveguide 16, $\beta = 2\pi/\lambda$ where λ the wavelength for waveguide 16, and L_1 (Fig. 2a) is the length for the short circuited end of waveguide 16, which is an open circuit. and the The input impedance Z_{in} for the equivalent circuit of Fig. 2a becomes:

$$Z_{in} = -jX_c + jX_1 + Z_{44-44} \quad (2)$$

where X_c (Fig. 2a) is the absolute value of the capacitive reactance of waveguide 16, X_1 (Fig. 2a) is the absolute value of the inductive reactance of waveguide 16, and Z_{44-44} (Fig. 2b) is the impedance looking into transformer 30. When probe 10 is shaped such that the reactances cancel, an impedance match is obtained when Z_{44-44} (Fig. 2b) equals Z_g (Fig. 2a). For the single step quarter wave transformer, $Z_t(L_2)$ (Fig. 2b) is found from the following equation:

$$Z_t(L_2) = \sqrt{Z_g(Z_{coax})} \quad (3)$$

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which is constant as a function of length L_2 (Fig. 2b).

Please replace the paragraph beginning at page 7, line 2, with the following amended paragraph.

Referring to Figs. 3, and 4, Fig. 3 depicts a tapered transformer 50 which has a tapered conductor 52 and a dielectric 54 with an outer diameter which is uniform. As shown in Fig. 3, the tapered transformer 50 is electrically connected to probe 10 for waveguide 16. Fig. 4 depicts a transformer 60 which has a stepped conductor 62 and a dielectric 64 which has a uniform outer diameter. The transformer 60 of Fig. 4 has a plurality of steps 66, 68 and 70 with each step 66, 68 and 70 having a different diameter. The lengths of each step 66, 68 and 70 of transformer 60 are usually equal as shown in FIG. 4. As shown in Fig. 4, the stepped transformer 60 is electrically connected to probe 10.

Please replace the paragraph beginning at page 8, line 16, with the following amended paragraph.

For the stepped version, the number of steps is arbitrary

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and can be different than the three steps as shown in FIG. 4.

The steps 66, 68 and 70 of the stepped transformer 60 may also have different lengths. The transformer 60 illustrated in Fig. 6 has a stepped conductor 62 and a dielectric 64 which has a uniform outer diameter. The transformer 60 of Fig. 6 has a plurality of steps 66, 68 and 70 with each step 66, 68 and 70 having a different diameter. The lengths of each step 66, 68 and 70 of transformer 60 are not equal as shown in FIG. 6. Probe and transformer diameters may also be non-circular.